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AUTHOR Winer, Jane L.; And Others
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ABSTRACT

An interdisciplinary effort by Texas Tech University to help undergraduate civil engineering students make better-informed occupational choices is the subject of this paper. The theoretical and empirical bases of the project, which is designed to improve counseling of freshmen students for both inter- and intra-occupational decision making, are presented. The paper is divided into four sections, each of which deals with a different aspect of the topic "Psychological Models of Engineering Careers." Occupational similarities and differences within and between several types of engineers are examined in the first section which reviews research in the field of engineering. In the second section, psychological decision theory is suggested as a framework for studying career decision making. General models of career decision making are discussed, the career decision making of college students is reviewed, and career decision models which expand the general models to give a more comprehensive view of college students' decision behavior are examined. The match between engineering students and their career choices is discussed in the third section. An analysis of the Strong-Campbell Interest Inventory is provided in the final section. Each section is complete within itself and contains its own list of references. (NRB)

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Psychological Models of Engineering Careers

Jane L. Winer, Linda McDonald, JoAnn Johnson,

Richard D. Weeter, and William Waltz

Texas Tech University

Southwestern Psychological Association

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Abstract

An interdisciplinary effort is underway at Texas Tech University to help undergraduate civil engineering students make better-informed occupational choices. Engineering does not easily fit the career definitions used by the vocational psychologist, since technical skills and work activities do not define the occupation reliably across time. The theoretical and empirical bases of a project which is designed to improve counseling of freshman students for both inter- and intra-occupational decision making are presented in this and related papers. Future presentations will report on data and empirically derived predictive methods. Occupational differences and similarities, preference and choice, career decision-making, and an introduction to the Strong-Campbell Interest Inventory are the topics of major interest in the present review.

Psychological Models of Engineering Careers: Occupational Similarities and Differences Within and Between Several Types of Engineers

Overview

A considerable body of personnel literature pertains to the idea that interoccupational differences are more important for devising a classificatory system than intraoccupational differences. This assumption, from which derives the assumption that engineers reflect a homogeneous population in regard to aptitudes, interests, or personality characteristics, is questioned. It is concluded that the construction of job families for parsimonious conceptual purposes has led to contradictory research findings and has aided in masking the true variability inherent in many occupations. The profession of engineering provides support for this conclusion, in that each subarea of engineering can be further divided into the functional task areas of basic research, applied research and development, production and process, and sales.

Introduction

The generally accepted notion that the similarities within an occupational group are more important than the differences has provoked controversy in the vocational literature (Zytowski & Hay, 1984). The necessity of a systematic and parsimonious classification system has led researchers to ignore the differences within occupational families and to emphasize the differences

between families (Arvey & Mossholder, 1977). Dolliver and Nelson (1975) maintain that the differences within occupations may be more important than the similarities and that attempts to differentiate occupational groups have been oversimplified for conceptual purposes.

Stutzman (1983) provided support for the hypothesis that posititons within a single job classification differ significantly from one another by comparing responses of mental health facility employees on a Time Spent Scale for 28 task based dimensions. Highlighted in this study are the problems encountered when using job classification information for selection, placement, or evaluation. A reasonable conclusion that can be extrapolated from these data would seem to be that using composite job family data for making decisions in the realm of work behavior will increase the likelihood that the variability within occupations may be hidden.

In contrast, Pearlman (1980) reviewed the personnel literature on job family classification efforts and concluded that there was no need for a molecular analysis of the specific tasks of individual jobs. This view stems from an emphasis on the similarities within a job family, defined as a set of interrelated jobs. The job family approach makes the assumption of similarity implicit, but does not take into account the possible differences within the same set of jobs. Paramount in importance in the decision to group particular jobs into families is the grouping's intended purpose. Pearlman (1980) stresses the utility and wide range of applicability of such

groupings. This assertion seems tenuous when the differences within job families are considered. There may well be as many jobs as there are people working (Kuder, 1977).

How important for vocational counseling are the differences in personality characterisitcs of individuals occupying the same type of job? As with studies dealing with the work environment, studies dealing with personality characteristics have been primarily concerned with the similarities of persons within a particular job, differences between persons in different occupations, and average personality characteristics of persons occupying particular positions (Holland & Holland, 1977). Cochran, Vinitsky, and Warren (1974) surveyed clinical psychologists and found a great deal of variety in personal style and operating environment. These results are supportive of the notion that neither work environments nor individuals are static and that important differences are to be found in both.

Engineering Research

The traditional approach taken by many vocational psychologists has been to attempt to match an individual, based upon aptitudes and expressed or measured interests, to an occupation (e.g., Crowley, 1983, Holcomb & Anderson, 1978; Slaney & Slaney, 1981). However, if the general occupational categories are defined too broadly it will be difficult to discern the relevant aptitudes as well as the defining interests of individuals in that field, and many mismatches

will occur. The profession of engineering exemplifies the possible problems which may be encountered when an occupational area is defined too broadly. Erez and Shneorson (1980) demonstrated that engineers working in industry can be differentiated from engineers in academics and that engineers in academics are more similar to individuals of different disciplines in academics than to their industrial counterparts. Engineers in academics were found to score higher on the Artistic type and lower on the Enterprising type than engineers in industry on Holland's Vocational Preference Inventory. Holland (cited in Erez & Shneorson, 1980) described the Artistic type person as someone who feels himself to be original, nonconforming, introspective and independent. Conversely, the Enterprising type strives for achievement and gains satisfaction from manipulating others for personal and organizational success. These contrasting interest patterns are consistent with the environment each type of engineer, academic or professional, will be operating within. Therefore, at a very gross level of analysis it is apparent that the intraoccupational differences in engineering are worthy of important consideration.

A number of attempts have been made to determine if engineers in industry differ significantly from scientists (e.g., Badawy, 1970; Kerr & Von Glinow, 1977; Korn, 1962; Mossholder, Dewhirst, & Arvey, 1981). Contradictory research findings from studies proposing to examine the nature of the relationship between

professionals and managers have led to the necessity of this differentiation between engineers and scientists in industry. The contradiction has arisen from the tendency of researchers to group engineers and scientists and to assume that there were no significant differences between the two (e.g., Hall & Mansfield, 1975; Misshauk, 1970). Kerr and Von Glinow (1977) found many differences between the two groups and concluded that engineers should not always be considered professionals. Basically engineers were seen as lower than scientists in level of expertise, need for autonomy, commitment to technical specialty, and identification with technical specialty. Consistent with these results are the findings of Goldner and Ritti (1967) which indicated that engineers are more career and management oriented than specialty task oriented.

In addition to exploring the differences between engineers and scientists on level of professionalism, Korn (1962) has looked at the differences using interest inventory scores. Using the California Psychological Inventory, the Strong Vocational Interest Blank, and a biographical data sheet as measures of interest, Korn (1962) compared measured interests with choice of major of students in engineering or the physical sciences. There was a great deal of overlapping interests especially in regard to an interest in the physical sciences. However, there were also important differences as indicated by significant chi-square tests. Engineering majors demonstrated higher interest than physical science majors in the

technical family occupational group; physical science majors manifested higher interest than engineering majors in the verbal-linguistic group. Engineering majors also scored much lower on the femininity scale of the California Psychological Inventory suggesting to Korn (1962) that the differentiation between the two majors is related to an individual's identification or role orientation.

Related to studies which attempt to differentiate individuals interested in engineering based upon personality factors are studies which attempt to delineate the similarites of individuals interested in engineering. Beall and Bordin (1964), who used past research and biographies of engineers to study the notion that all engineers share a basic framework of activities, suggested a number of commonalities among engineers. Included in the basic characteristics of engineers are strong identification with the masculine role, male authority, and an organization. Engineers are seen as more introspective and as preferring to work in an area without ambiguity. Although Beall and Bodin (1964) acknowledge that there are differences between the various groups in engineering, they feel that their results are fairly representative of all engineers. Izard (1960), using the Edwards Personal Preference Schedule, also identified a number of personality factors characteristic of engineers. As compared to Edwards' male norm group of 750 liberal arts students, experienced engineers scored

higher on Achievement, Deference, Order, Dominance, and Endurance and lower on Affiliation, Intraception, Succorance, Abasement, and Nurturance. The differences between the experienced engineers and the norm group were accentuated due to age and maturity, but the trend was the same when comparing sophomore engineering majors with the norm group. The differences were not as great, however, which suggests that the sample of freshmen majoring in engineering was not made up purely of those who would become engineers, as indicated by a high attrition rate of freshmen engineering majors. These studies show that even when analysis does not control for differences within the field of engineering, engineers on the average are found to share a number of similar personality characteristics.

Thus far this section has reviewed some of the relevant literature pertaining to the issue of grouping jobs into families based upon controversial data. Much of the research has emphasized the differences between widely divergent positions while ignoring the differences within positions. This method of analysis may be useful for conceptual purposes and for the identification of some basic personality and interest similarities within occupations, but for vocational counseling the utility of such a broad classification system is questionable. The problems with this type of system have been emphasized by reviewing the attempts to define engineering and the people interested in engineering. To successfully counsel prospective engineers it would seem that a molecular analysis of the

field is in order. The remainder of this section deals specifically with the differences within the profession of engineering and the people interested in this profession.

Engineering as a Profession

There are a number of specialty areas identified under the broad heading of engineering. As an undergradute interested in engineering a student may elect to major in engineering specialty areas such as electrical, mechanical, chemical, industrial, or civil. Training for each subarea differs considerably due to the substantially different material each has as its chief operating element. Generally, the principles of mathematics and science are applied to electricity by the electrical engineers; to the design and development of machines that produce power by the mechanical engineers; to the processes that change raw materials into useful products by the chemical engineers; to the way people, machines, and materials can be more effectively utilized by industrial engineers; and to the design and construction of major structures by the civil engineers ("What's it like to be an engineer", 1983). Obviously, the application of mathematics and science is a consistent similarity in engineering as most people perceive it. However, is that application important enough to group all these subareas into one family?

Izraeli, Krausz, and Garber (1979) found that industrial engineers were significantly different from engineers in other

specialty areas. Responding to a questionnaire, industrial engineers indicated a higher preference for working with people and a lower preference for working with things than mechanical or electrical engineers. They also viewed their field as more ambiguous than the other groups. These results are contrary to other findings which have found that engineers prefer working with things to working with people and that engineers have an aversion for ambiguity (e.g., Beall & Bordin, 1964; Izard, 1960).

A significantly greater proportion of the literature addressing the differences within the field of engineering has taken the differentiation a step further by attempting to delineate the variety of jobs and tasks within each specialty area (e.g., Dunnette, 1957; Dunnette & England, 1957; Dunnette, Wernimont, & Abrahams, 1964; Kirchner & Dunnette, 1958; Kulberg & Owens, 1960; Webster, Winn & Oliver, 1951). The engineering task functions identified within each subarea were basic research, applied research and development, production and process, and sales. Dunnette and England (1957) were able to empirically validate these distinctions with the development of the Job Description Checklist. They proposed and found that the duties on the Checklist exist on a continuum from basic research to sales. Dunnette et al. (1964), in a review of the literature, contributed to the meaning and usefulness of the four distinguishable task functions. They combined data (found in the studies reviewed) from the Strong

Vocational Interest Blank, correlations with other test scores, observer and supervisory ratings, biographical information, and adjectival self descriptions to arrive at a meaningful summary of the relevant differences between the differentiated task functions within each subarea of engineering.

Engineers employed mainly in basic research were found to have interests similar to those of persons working in basic scientific and theoretical areas. They seemed to be more intelligent and technically superior to those not working in basic research. They seemed to prefer working alone to working with a group and were less dominating in interpersonal situations than were persons not in this area. Basic research engineers were generally rated high in technical competence but were more often associated with unfavorable adjectives such as awkward, high-strung, impulsive, peculiar, tactless, rude, temperamental, and foolish. Engineers high in the research area were more object oriented and less people oriented. Engineers in applied research and design exhibited many of the same characteristics as engineers in basic research, but differed in the degree to which they expressed these characteristics. Basic research and applied research and design engineers closely represent the stereotypic view maintained by many researchers when defining engineering as one job family.

Production and process engineers were similar in many ways to sales engineers. The main difference between the two was that the

interest patterns of production and process engineers were more similar to those of engineers in applied research and development than to those of sales engineers. Sales engineers expressed interests similar to those of persons in the selling occupations and independent business management. They placed greater emphasis on interpersonal effectiveness than on intellectual or technical knowledge. Sales engineers were generally rated low in technical competence but were often associated with favorable adjectives such as confident, handsome, optimistic, outgoing, good-natured, cheerful, and attractive. Sales engineers were usually highly ambitious and aspired towards high-paying executive jobs but were almost entirely lacking in interest or ability in technical skill. From this description of engineers in production and process and sales, it is apparent that these engineering subspecialties do not fit the stereotypic image maintained for engineering as a profession.

The distinction made between research and sales engineers by Dunnette et al. (1964) seems consistent with and similar to the distinction Erez and Shneorson (1980) made between engineers working in academics and engineers in industry, as well as the distiction Kerr and Von Glinow (1977) made between scientists and engineers. With over 25 years of research data as evidence, the differences within the profession of engineering and the people working in this profession are too great to ignore. Perhaps future research on job families should question the assumption of occupational homogeneity.

The identification and demarcation of heterogeneity within engineering in general and civil engineering in particular should increase the ability of vocational counselors to predict successful occupational choice categories based upon student interests. In order to delineate the subareas within civil engineering a strategy similar to that of Dunnette (1957) and Dunnette et al. (1964) seems most reasonable.

Initially it will be important to operationally define the four task areas of pure research, applied research and development, production and process, and sales. This could be done with the administration of a Time Spent Scale for task based dimensions to engineers already working in the field. This scale could be similar to the Job Description Checklist constructed by Dunnette and England (1957) for differentiating engineering jobs. Expeditiously, these same engineers could be asked to complete the Strong-Campbell Interest Inventory. From these combined data it should be possible to develop scales on the Strong-Campbell Interest Inventory which represent the four functional categories within civil engineering. This seems to be a feasible task and has been shown to be useful by Dunnette (1957), who developed special scoring keys that differentiated between the four major areas on the Strong Vocational Interest Blank. Knowing the interest patterns of persons employed in each of the four functional categories within civil engineering should significantly increase counseling effectiveness of students

making crucial educational and career decisions.

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Psychological Models of Engineering Careers:

Career Decision Making

Overview

In this section psychological decision theory is suggested as a framework for studying career decision making. General models of career decision making which adopt framework are reviewed. Process theory is described as the most useful theory for conceptualizing an ongoing decision making process. The career decision making of college students is reviewed as a single period in the career decision making process. Career decision models which expand the general models to give a more comprehensive view of college students' decision behavior are reviewed. Engineering students are suggested as a potential population to develop an even more extensive model of career decision making. Research needs to be conducted to discover the factors which influence the career decision process of this narrowly defined population.

Introduction

Career theory has evolved since its inception from a relatively static theory to a dynamic one (Sonnenfeld & Kotter, 1982). The first type of career theory considered social class determinants of occupational choice. More specifically, an individual's social class influenced both the individual's career aspirations and the occupational opportunities available to the person (Blau, Gustad,

Jesser, Parnes & Wilcock, 1956). As social mobility of the classes increased, career theory began to consider static dispositional differences of individuals in various careers. This search for a relationship between personal traits and the occupation in which people are employed is exemplified in the widespread use of the Strong Vocational Interest Blank and its successor the Strong-Campbell Interest Inventory. Using either instrument, an individual's interest profile is compared with the profiles of those already employed in various occupations. The third phase of career theory focused on the development and process of career stages (Tiedeman & O'Hara, 1963). This phase of the development of theory concluded that careers develop in a somewhat predictable manner. The fourth phase extended the third to consider the entire lifespan of the individual (Mihal, Sorce, & Comte, 1984). Researchers in this phase consider career development to occur across the lifespan.

A dynamic view of career development is suggested by both the stage and lifespan approaches. One conceptual model for viewing these approaches is the decision making model (Jepson & Dilley, 1974). Decision theory attempts to explain how choices are made. The framework of decision theory assumes an individual to make the decision, a problem that must be solved, pertinent information, alternatives, and anticipated outcomes. Zakay and Barak (1984) described the decision making framework of career decision as one in to which the individual defines the problem, generates alternative

actions, gathers information pertaining to each alternative, processes the information in terms of the value, makes plans, and implements them. The individual is an active participant in the decision making process construed in this way.

There are two general models of vocational decision making. The first is a descriptive model. This type of model seeks to describe the ways people generally make career decisions. The second model is a prescriptive one. This type of model attempts to improve the decision process by reducing errors. This section first addresses the descriptive models, which are the bases of traditional prediction and counseling, then the prescriptive models, and finally discusses the latter with regard to application.

Review of Literature

Tiedeman and O'Hara (1963) utilized a stage approach to describe career decision making. In their theory, decision making occurs in two phases. The first phase is anticipation, during which the individual (a) explores different goals in an attempt to differentiate among them; (b) assesses the goals in terms of their costs and benefits; and finally, (c) selects one goal. In the second phase, that of implementation-adjustment, the individual implements a plan to achieve the selected goal.

Vroom (1964) developed an expectancy model of decision making whereby he expanded upon the anticipation phase described above. In the expectancy model, the individual has a valence (or preference)

for each outcome which enables him/her to differentiate among outcomes. Each outcome also has associated with it an expectancy. The expectancy is the individual's subjective probability that the outcome can occur. The product of the valence and the expectancy of each outcome is termed the force toward that outcome. Selection of a given outcome is determined by the size of the force. Essentially, the individual is conducting a cost/benefit analysis for each outcome and selecting the alternative which results in the greatest benefit.

Hilton (1962) based his decision model on information process theory. Hilton suggested that people hold certain premises (beliefs or expectations) concerning themselves and their world. When a person is confronted with new information, cognitive dissonance can occur if the information is contrary to existing premises. When cognitive dissonance occurs the individual has two alternative courses of action. The individual can revise existing premises so that the information is no longer contradictory, or he or she can consider alternate plans. The concept of cognitive dissonance was further explained by Thomas and Bruning (1984) as as action producing drive state which is itself produced by cognitions which cannot fit together into a schemata (an inter-related network of existing cognitions.) The selectivity of information processing was focused on by Pitz and Harren (1980). These authors stressed the importance of individual differences in decision making by emphasizing that each individual represents knowledge differently. Thus, a cognition which

may result in dissonance for one person may easily fit with another's existing cognitions.

From decision theory and expectancy theory a process model of career decision making was developed by Mihal et al. (1984). Mihal et al. posited that career decision making occurs across the lifespan at varying degrees of intensity. They construed a career as an ongoing relationship between an individual's work and nonwork roles. According to their model the career decision making process is initiated when the individual perceives a discrepancy between his or her current career state and the so-called "ideal" state. Variables which influence the perception of this discrepancy can be generated externally (e.g., less than desired advancement in current job) or internally (e.g., changing personal interests) or may result from the person's career stage. Once the problem is perceived the individual begins to formulate a tentative strategy for solving it and begins to search for pertinent information. Phillips (1982) suggested that there are two types of information search: exploratory and terminal. The former involves the generation of alternatives, whereas the latter uses information to choose among alternatives. Information can come from memory (fantasy) or from the environment (family, employment services, etc.). As the individual gathers information, he or she establishes a set of criteria for evaluating the alternatives which come into awareness. If there are several alternatives the individual will reduce the number using

non-compensatory procedures (i.e., procedures which consider only a few attributes) and then select the preferred of two alternatives using a compensatory procedure (i.e., a procedure which considers all of the attributes of a given alternative).

Reviewing these descriptive models, one can see that the general view fits that occupational choice fits a maximizing model (Kaldor & Zytowski, 1969). The personal resources put into the system are applied to each occupational alternative, and certain consequences (outputs) are said to follow. The selected alternative will be the one with the highest value when input costs are compared against output gains. Kaldor and Zytowski (1969) listed three general determinants of occupational choice: the individual's preference system, the resources available for generating the occupational outputs, and the outputs.

These models suggest a very rational view of decision making. Many researchers argue, however, that career decision making is not the neat package these models describe. Fletcher (1966) assumed that the decision process is a function of timing. A career concept is a composite of several factors including self-concept, interests, attitudes, and values associated with each career alternative. Each career concept has an affective feeling associated with it. The chosen career is the one with the strongest affective feeling at the time of the decision. Rothstein (1980) argued that occupational choice often arises from an opportunity rather than a search for

alternatives. The degree to which individuals have knowledge of the alternatives has also been questioned (Pitz & Harren, 1980). Lastly, Mitchell and Beach (1976) raised the question as to how selective probabilities can be measured. In general these questions address the problem of measurement that most psychologists are faced with: how does one measure the processes which ostensibly occur in the mind of another person? It is not the purpose of this section to debate such an issue; however, the criticism of measurement processes must be mentioned when discussing the cognitive theories which have, in general, abandoned traditional psychometric methods.

Despite the general criticism, many researchers have found empirical support for the career decision making model. A study be Pieters, Hundert, and Beer (cited in Mitchell & Beach, 1976) used a decision model containing an index of attractiveness (IA). Subjects were recruits at Corning Glass Works. Each recruit rated the attractiveness (utility) and importance of a number of job characteristics for several alternatives. The attractiveness rating was weighted by the importance rating by multiplying the two ratings and summing over characteristics. The IA was used to predict job choice. The results showed that 86% of the applicants chose the job alternative with the highest IA. Mitchell and Knudson (1973) studied the attitudes towards business of 106 students as related to these students' occupational choice of business or non-business. A significant correlation was found between Vroom's expectancy measures

and the students' choices.

Models of career decision making have also been developed for select populations. Harren (1979) suggested that in order to understand career decision making within the context of career development, it is more practical to focus on a given period in the lifespan and ascertain how decision making and development interrelate at that given time. He further observed that although this type of microtheory is limited in its general application, it can be comprehensive within its range of application. Harren also indicated that similar microtheories could be used in a model building attempt. Several researchers have focused upon the collegiate period as the critical career development moment within the lifespan (Elkins, 1975; Harren, 1979; O'Neil, Ohlde, Tollefson, Barke, Piggott, & Watts, 1980).

Harren (1979) presented a rather complex model of career decision making for college students. The model proposes four basic parameters: process, characteristics, tasks, and conditions. The process stage is a four part decision making process consisting of an awareness phase, a planning phase, a commitment phase, and an implementation phase. The awareness phase is something of an assessment phase during which the individual considers his or her present situation versus desired situation. If the result of this assessment is dissatisfaction, the student moves into the planning stage, during which exploration of alternatives occurs. This phase

ends when the individual settles on one alternative. The commitment phase begins as a private decision, but then the decision is tried out on significant others. If the feedback from the others is positive the individual will implement the decision in the final phase. The characteristic, task, and condition parameters influence the decision process. In general the characteristics are those relatively stable personality traits of self concept and style that influence both the individual's perception of the tasks and conditions and the individual's progress through the process stage. Tasks are career relevant developmental tasks of college students. Conditions are immediate and anticipated situational factors that influence the person. Style is an important characteristic in that it describes how the person generally makes decisions. There are three general styles: rational, intuitive, and dependent. Individuals of the first two styles take responsibility for their decisions, whereas those of the third style place the responsibility away from themselves. The first two styles differ in that the rational style involves more information seeking behavior and analysis of consequences whereas the intuitive style is based more on affect. The three developmental tasks offered by the model are: autonomy, interpersonal maturity, and sense of purpose. As one masters these tasks the identity of one's self concept is further clarified. The condition parameter consists of four types: interpersonal evaluations, psychological states, task conditions, and

context conditions. The task conditions require special attention here. These refer to specific career-relevant tasks, such as choosing a major or interviewing for a job. The three task conditions are: imminence, alternatives, and consequences. Imminence is a measure of the time remaining until a decision must be implemented. Alternatives are the differing courses of action available. Consequences are those gains and losses associated with each stage of the process. Progress through the process depends upon the characteristics of the individual, the type of the decision, and the context of the situation.

One can see from reviewing Harren's rather complex model that it is a refinement and integration of the general models discussed earlier in this chapter. The process stage is an elaboration of the process model also developed by Mihal et al. (1984). In the case of Harren's model, elaboration is in the area of the factors which can influence individual decision making styles. These factors include characteristics, tasks, and conditions. These three parameters are extensions of Vroom's expectancy-value theory.

Other researchers also attempted to identify the factors which influence the career decision making of college students. O'Neil et al. (1980) found evidence to support O'Neil's model of six general factors which affect career decision making. These six general factors were identified as familial, societal, socioeconomic, psychosocial, individual, and situational. Each of these general

factors is defined by a subset of factors. In a cross sectional study the authors found that these six factors explained 60% of the cumulative variance when subjects were asked to complete a checklist of the factors which affected their career decision making. The individual factors (self expectancies, abilities, interests, attitudes, and achievement needs) were reported by 84% of the sample as influencing them "very much" or "somewhat." Elkins (1975) also found that individual factors were important in the career decision making of college students. Participants in a career development workshop were asked to list the ten factors which would most influence their career decision making. Those factors most often identified by the sample were interests, opportunity, earnings, satisfaction, abilities, location, goals, and personality (listed in rank order).

As suggested by Harren (1979), these researchers have been able to refine the general decision making models by narrowly defining the population to which they desire to apply their models. These studies of college students' career decision making delve further into the factors which influence the process. Further analysis of even more narrowly defined populations may result in an even more comprehensive model which can be used in counseling a specific population.

The Models Applied to Engineering Students

The population of engineering students is a subcategory of the general population of college students. This narrowly defined

population can be further divided into the speciality areas. In the early 1960's there was a shortage of students entering the field of engineering; thus, there was a need to discover the factors which would influence a student to select this field (Smith, 1960). A survey was sent to engineering students at randomly selected colleges, asking the students to identify the principal influence in their selection of engineering as their academic major field. The results showed that the family was the single greatest influence, followed by teacher, friends, high school counselor, and the availability of scholarship monies. However, 44% of the respondents gave reasons other than those listed on the survey. Among these other influences were personal interest, past experience, aptitude, and a preference for mathematics and science. Results of a similar study conducted by Durchholz (1979) showed that a perceived ability for math and science was the major influence in the choice of major field for freshman engineering students. Other influences included encouragement by other people (especially parents and teachers), opportunity, and an interest in problem solving. An interesting result of the survey was the finding that although these students had selected engineering as their field, few could explain what an engineer actually does. Durchholz concluded that the students' lack of understanding was a result of their limited exposure to advanced course work with any direct application to engineering. Another survey conducted by Ott (1976) found that 37% of the students cited

an intrinsic interest in the field as their major reason for selecting engineering; the second most popular reason was the availability of job openings. Finally, in a comparison of men and women undergraduates at Purdue University, Jagacinski and LeBold (1981) found that work characteristics and high school mathematics and science courses tended to be the greatest factors of influence. From these four surveys a general trend can be noted. Extracting from the previous studies of decision making of the general college population, engineers appear to focus on individual and socioeconomic factors in making their career decisions.

Medvene and Shueman (1978) studied the familial factor with regard to the choice of specialty area of male engineering students. They found a significant relationship between choice of job function and early parent-child interactions. In general those individuals who selected sales and technical service specialties described their dominant parent as accepting, whereas those who selected research and development described their dominant parent as avoiding. These findings are supportive of an early career decision theory presented by Roe (cited in Osipow, 1983). Perhaps for engineers the influence of the familial factor is important at the level of specialty area selection.

The prescriptive models of career decision making, as noted earlier, attempt to improve the decision making process. Since the major focus of this paper is the career decision process of

engineers, it is important to consider earlier efforts to improve the career decision process of engineering students. The career information needs of entering college freshmen were surveyed at Bowling Green State University (Walters & Saddlemire, 1979). The results showed that the students' greatest need was for information on the occupations for which a given major might provide preparation. Another important need was for a better understanding of oneself in terms of values and goals. Students also desired more direct work experiences in possible future occupations. Prien (1980) approached the problem of informed decision making among engineering students by focusing on the needs described by the general freshman class. A Committee on Engineering Preparation developed a guidance program whose goals included a) to make information concerning engineering as a career available to all high school students, b) to make available to counselors information on guidance for careers in engineering, and c) to secure funds to support the development, production, and distribution of career information and guidance. At Carnegie-Mellon University, a restructuring of the freshman engineering curriculum was designed to aid the student in making informed career choices (Moore, 1969). The engineering student is permitted a choice of courses offered by the five engineering departments during the freshman year. Therefore a student can opt to take several courses in a given area, or if the student is undecided as to a speciality area he or she can opt to "shop around". Also under this program,

senior faculty members teach the freshman class so that students can experience some degree of contact with them. The changes in the curriculum were implemented with the desire to permit freshman and sophomore students to learn more about the engineering specialties before a career decision had to be made.

Conclusion

The early career theories have lost some of their value in our increasingly complex society. Advancements in technology have resulted in the rapid creation of new careers and a corresponding obsolescence of other occupations. An individual no longer is constrained to follow in the career path of his/her parents. This new freedom has made the career decision process a complicated matter for both the individual and the career counselor.

Counselors need to improve their services to meet the needs of the student population which is involved in this critical decision making process. As suggested by the survey at Bowling Green State University (Walters & Saddlemire, 1979), students express a need for information concerning the occupations associated with their major and for a better understanding of their own interests and values. The prescriptive model of career decision making would suggest that if students were provided with this information they could increase their ability to make informed career decisions.

In the case of developing a counseling program for engineering students, this information can be gathered from several sources. A

questionnaire could be completed by engineering alumni which would address the notion of what engineers in the various subspecialties actually do in their jobs. These questions should be designed such that the responses would allow one to differentiate among the specialty and subspecialty areas. Data should also be gathered from the alumni concerning their interests. The Strong-Campbell Interest Inventory could be used for this purpose. Although this inventory fails to differentiate among types of engineers, responses could be used to develop specialty keys for the various types (McCampbell, 1966, cited in Molnar & DeLauretis, 1973). Such data should be able to provide the student with adequate information concerning the activities and responsibilities of various types of engineers as well as the interests of engineers in the specialty areas.

Secondly the student should be helped to focus on his/her own personal interests and values. As indicated by Ekins (1975) students are able to list those factors which would most influence their career decision making. Krumboltz, Rude, Mitchell, Hamel, and Kinnier (1982) conducted a study of simulated career decision using college students as subjects. A unique aspect of this experiment involved requiring the students to indicate among a set of nine personal work values the three most important, the three least important, and the three of intermediate importance for them. In doing so, each student was assigning a criterion weight for selecting among career alternatives. Later in the experiment the student was

provided with information on fictitious careers. Each piece of information allowed the student to consider the career in terms of the nine personal work values. A student was judged to have made a good career decision if the characteristics of the chosen career were consistent with the values of the student. Such a procedure would be possible and useful in the counseling of the engineering student. From the alumni responses to the questionaire and the Strong-Campbell Interest Inventory a set of global values for engineers could be constructed in terms of interests and work-related tasks. The student could then be asked to rank these values in terms of his or her own interests and values. Finally the student could be provided with information concerning the engineering specialty and subspecialty areas. By using both the objective information and their subjective values, students should be able to follow the maximizing principle and conduct a private cost/benefit analysis for the career alternatives. Each student should then be able to select the specialty area which maximizes the outcome of consistency with personal interests and values.

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Psychological Models of Engineering Careers: The Match Between Engineering Students and Their Career Choice

Overview

Historic attempts to predict stability for engineering careers centered on various forms of scholastic aptitude prediction. A modern approach would include factors affecting preference and choice of entering engineering students. By combining preference and choice factors, a more accurate model of suitability for engineering careers could be produced.

Introduction

The Civil Engineering Department at Texas Tech University is concerned with the problem of "goodness of fit" between civil engineering students and their careers. This is not a novel concern for engineering academicians. Traditionally, however, the answer to this matching problem has been sought along objective lines of reasoning. Despite a considerable degree of success at predicting a student's performance in engineering curricula, such approaches still leave large amounts of incompatibility unexplained. Such approaches often fail to consider the congruence between the student and the total career, instead focusing on the prediction of an individual's ability to do well in a particular educational program.

The addition of a more subjective approach to the problem of

engineering student/career congruence may help explain some of the "cracks" unaccounted for by traditional approaches. It may also provide some focus on vocational issues of an engineering career not addressed by traditional assessments.

A Brief Historical Perspective

A great deal of effort has been expended across a considerable time span on the problem of matching an individual with an engineering education. The majority of early studies focused on the prediction of success in college engineering courses.

The American Association of Engineers sponsored one of the earliest works, Vocational Guidance in Engineering Lines (Waddell, Skinner, & Wessman, 1933). The book provided a somewhat romanticized view of the various fields of engineering, embellished with poetry and endorsements by such prominent men of the time as President Herbert Hoover, General John J. Pershing, and Colonel Theodore Roosevelt. In the foreward, it is noted that the selection process or "weeding out" of the obviously unfit was costly, both to the school and the engineering student. The purpose was briefly stated:

> The Association feels strongly that any undertaking which retards the entrance into engineering schools and the profession itself of those not naturally fitted for the work must strengthen the profession and make it possible for its members to demand rewards in proportion to increased efficiency. (p. vii)

Commenting on assessment, a psychologist advised that unless a student was above the average of high school students in intelligence he would not be able to pass the curriculum requirements for engineering. The likelihood of a woman selecting or surviving an engineering curriculum was sufficiently low that the pronoun "she" was not used in such prediction. Grades in preparatory school were suggested as predictors of scholastic and professional success. It was suggested that the aspirant be in the upper third of his class. Good academic work in physics, mathematics, and chemistry were also possible indicants of success. It was cautioned that tests of mechanical aptitude were of doubtful validity, tests for measuring interests were not perfected, and that traits of character could not be measured.

Although it may be quaint by present standards, the book and the practical advice of the time represent an earnest attempt to help possible engineering students make suitable vocational choices. In some regards, the work offered students advice which is of timeless relevance:

> In order to judge whether the profession of engineering would be a good vocation for you to follow, you must examine the occupation and see what it involves. You must also analyze yourself to see if you possess or can acquire the

> necessary qualifications... Counsel with persons who are qualified to give advice regarding vocational matters. Talk with men who have succeeded in the profession of engineering.... Having obtained all the pertinent facts, you will be able to render a reasoned decision. (Kitson, 1933, p. 49)

By the 1950's, the approach to matching the student with the engineering curriculum had become much more involved with objective data. Layton (1954) provided a review of the literature correlating engineering grades and certain specific predictors. He reported research resulting in correlations of .55 between high school achievement and engineering students' first year grades. Correlations between scholastic aptitude tests and grades were reported as about .45. Mechanical and spatial aptitude tests had a correlation of about .35, science aptitude tests about .45, mathematics aptitude about .50, physics, chemistry and science achievement tests about .45, and English achievement tests about a .40 correlation with grades. Various attempts to combine these predictors resulted in multiple correlation coefficients ranging from .40 to .85, with the average being .65. In general, high school grades, mathematics tests, and aptitude tests were found to be the best predictors of grades in engineering courses.

Eller (1958) cited several specific criteria for identifying

potentially successful engineering students. High school grades, intelligence, ability in structural visualization, and certain activities and attitudes were considered important indicants. Eller cautiously reported early studies which examined the relationship between interests and ability.

Recent Approaches

Although not specifically concerned with engineering, several more recent attempts to detail the relationship between objective aspects and career choice have been made. Becker and Mowsesian (1976), for example, presented an economic model of the decision process. According to this model the decision to engage in particular training is a function of the expected monetary and psychic returns in relation to the expected monetary and psychic costs to the individual. The monetary rewards of an occupation are obviously important in making career choices. The costs of training for a particular occupation are also important considerations. There are other factors to consider as well. Vroom's (1964) expectancy model, for example, suggests that in addition to the attraction one feels to an occupation, vocational preference is also affected by the expectancy of being able to attain the requirements of the occupation.

Although there are reliable relationships and useful models to use as guidelines, the total "goodness of fit" between engineering student and career success remains less than exact. It is an unfortunate reality that some students choose to enter engineering

programs with inadequate aptitude. It is also unfortunate but true that some students, possessed of the requisite aptitude, leave engineering programs after investing considerable time and effort because they have reassessed their interests. Considering that success in engineering courses can be predicted fairly well with objective measures, part of the incongruency the academicians are concerned with must be the perceived unsuitability of some individuals for the field, regardless of their academic aptitude for engineering studies.

Crites (1969) identified three basic patterns of incongruency between an individual and an occupation. An occupation could be chosen which required greater aptitude than was possessed; an occupation below the level of competence could be chosen; or the individual could choose an occupation congruent with aptitude but inconsistent with interests. Traditional engineering school approaches have dealt primarily with the first two patterns. The third pattern, dealing with subjective interests, has been virtually ignored by engineers.

Palmerton (1954) directly addressed the problem of counseling engineering students. He suggested the concept of vocational interest as a crucial variable in the success of engineering students. Most "casualties" in engineering, he felt, could either be blamed on a lack of aptitude or a lack of interest, but there was a tendency to attribute the failure primarily to lack of aptitude.

Most drop-outs, however, were above the average high school rank and scored well on entrance tests. This suggested an examination of the importance of interests. Although measured interests provide an important source of information relevant to decision making, Palmerton did not suggest the immediate rejection of individuals who did not score highly on the engineering key of the Strong Vocational Interest Blank. Instead he suggested such students might find engineering an excellent background for other careers; their other interests might combine with training in engineering to produce unique and productive careers which might not be immediately predictable.

The congruence between an aspiring student and success in school or a career cannot be perfectly explained by easily quantified objective relationhips. An expansion of the prediction model to include more subjective factors such as personality and perceptual processes as well as measured interests is required.

Subjective Factors

The various objective quantification schemes do not predict suitability of engineering students in their studies with 100% accuracy. Therefore, other factors particular to the individual must be involved. One of the fundamental assumptions in psychological theories relating individuals to occupations is that there is a lawful relationship between a person's subjective experience and the chosen occupation.

Several general descriptions of engineers have found their way into the psychological literature over the years. For example Kulberg and Owens (1960) provided a description of the typical engineer as having a history of unsuccessful and somewhat painful interpersonal relationships and a record of superior performance in science along with greater enjoyment of quantitative and practical courses than of linguistic and social studies. They also described the prospective engineer as having a long history of career planning, of liking to work with things and ideas as opposed to people, and of enjoying creative work and disliking routine. Weller and Nadler (1975) reported that students of engineering and physical sciences were higher in authoritarianism than were students in the social sciences and the humanities. As a result, they suggested engineers would be unlikely to question the basic assumptions of their discipline. Danielson (1960) reported that supervisors and cohorts of engineers felt that engineers as a group had a so-called "different" kind of personality. Engineers and scientists were felt to be more ambitious, creative, analytic, individualistic, and introverted than the typical person. Danielson pointed out that part of the practical significance of such findings is that there is a more extreme manifestation of these characteristics in groups such as engineers and that these individuals themselves recognize a difference between themselves and most others. Such global generalizations are usually of only anecdotal interest; in the case

of engineers, however, they may be of even less use. Fretz (1972) reported that data schemes which assessed background factors such as school history, family background, moral development, early trauma, and interpersonal development, were less predictive for engineers than for second year students in education, law, medicine, and business.

The psychological approach to vocational behavior contains many areas of focus. One of the most primary areas may be generally referred to as "preference and choice". The type of occupation an individual would pursue under ideal conditions constitutes one's preference. The type of occupation actually pursued constitutes one's choice. The occupation preferred and the occupation chosen may not be the same. Factors which create improper or unrealistic preferences and environmental constraints which limit possible choices often distort the process.

There are two basic approaches to the study of vocational preference and choice. One approach is concerned with the evolution of the preference and choice process throughout the development of the individual. The second approach is concerned with the attraction between a particular type of individual and an occupation. By sampling this attraction process at several points in time (not just as students enter college) the theories and method of both approaches can be used.

Supporting the latter approach, Holland (1966) reviewed

literature which suggested that there are four to eight dimensions or general categories of vocational interest. According to Holland, a small number of personal dispositions may account for what we know about concepts of vocational interests, preferences, choice, and occupational membership. Essentially, an individual has certain dispositional traits which influence the preference and choice process. Someone with scientific interests, for example, would seek scientific training as a result of a relatively stable disposition which had expressed itself in similar behavior at different ages. Individuals with similar traits tend to pursue similar occupations.

Holland claims that psychologists make the following assumption: people perceive occupations and their associated activities fairly accurately, and these perceptions remain the same over long periods of time. These perceptions are a foundation for each individual's preference and choice processes.

The accuracy and stability of a person's self-prediction was found by Holland and Whitney (1968) to be twice as efficient in prediction of choice as the highest scale score on the Vocational Preference Inventory. Along similar lines, Whitney (1969) reported that a person's expressed vocational choice predicts his or her future employment almost as well as interest inventories or combinations of personality and background characteristics.

Gottfredson (1981), however, reported that research indicated people tend to judge the similarities and differences between

occupations along a few simple dimensions. This judgment process is based on the gender of the prototypical person in an occupation, the level of the work, and the field (white or blue collar). She also reported that socioeconomic status (SES) affects the judgment process. People with higher SES tend to make finer distinctions between occupations of higher prestige than people with lower SES.

Apparently there is some controversy about an individual's perceptual performance on two factors, the accuracy of self concept and the accuracy of one's perception of an occupation. To the extent that one's perceptions are accurate, the preference/choice process will be augmented. To the extent that one's perceptions are inaccurate, the process will be distorted. Gottfredson (1981) indicated that to the degree self perception and occupational perception are compatible, vocational adjustment and satisfaction will be possible.

Self Perception

Holland (1966) pointed out a low to moderate correlation of interests to personality. Several studies (e.g., Besyner, Bodden, & Winer, 1978) have found some significant relationships between personality and predictive validity. Other aspects of the personality/occupation relationship have been examined as well. Southworth and Morningstar (1970) examined the persistence of the occupational and personality congruence. They found that, compared to those who left engineering, freshmen engineering students who

persisted in their engineering studies were more similar to upperclass engineering students in terms of interest patterns.

According to Ziegler (1970, 1973) as early as 1943 Borden suspected the existence of a specific relationship between self concept and vocational choice. Ziegler found evidence supporting a general notion of a relationship between personality and vocational preference. He found male college students who preferred a given occupational area tended to share certain self concepts which distinguished them from students who preferred other areas.

According to Greenhaus and Simon (1976), another aspect of self perception, self esteem, can be viewed as a small discrepancy between self concept and the ideal self concept. The smaller the discrepancy, the greater the self esteem. Self esteem and career salience jointly influence the extent to which an occupation is considered ideal or as satisfying certain intrinsic work needs. The importance of satisfying intrinsic needs indicates that the amount of financial reward for an occupation may not be as important a determinant for some people as for others. Some individuals are more likely than typical to pursue occupations for the intrinsic satisfaction. They will enter a field even when it is in a "lean" cycle in terms of prestige or financial compensation, presumably because the intrinsic satisfaction compensates adequately for lesser extrinsic satisfaction.

Perception of the Occupation

As was already noted, Holland (1966) indicated an important assumption of psychologists was that people maintained fairly accurate perceptions of occupations. This assumption implies that the stereotypes we create of particular occupations are directly related to our affective response to that occupation. In fact, as early as 1909, according to Burgoyne (1979), Parsons had the idea that occupational stereotypes were important factors in vocational decision making.

Ziegler (1973) found that individuals attracted to an occupation tended to share certain concepts about the kind of person found in that area. He also assumed that the individual must have some fairly clear idea of the kind of person that was in his or her preferred occupational area.

Banducci (1968) found that students tended to have more accurate perceptions about occupations which corresponded to their dominant scales. Marks and Webb (1969) found that students entering industrial management or electrical engineering possessed a "fairly accurate image--assuming the professionals know what they are talking about--of the typical incumbent of the intended occupation" (p. 298). Winer, Warren, Dailey, and Hiesberger (1980), however, found that subjects made less cognitively complex judgments about their own fields than about others; complex judgments may help the individual make the necessary decisions to reject the many alternatives available to them in favor of one specific choice.

Vocational Maturity

Recent research has looked at the stability of the perceptual process. Ware (1980) examined the relationship between a college major and a career as a perceptual-cognitive process. Students with less vocational maturity were more likely to generalize from their preference for a college major to their decisiveness about a career choice. The students with higher maturity could more readily discriminate between educational preferences and the certainty of a career choice.

Hansen and Ansell (1973) found that vocational maturity increases for all ages in high school and that the middle class white student tended to be more mature than lower class whites or blacks. This investigation and many others in the area of vocational maturity suggest that general experience with and exposure to the professional world of work eases the decision process among adolescents and young adults.

Other Factors

Factors such as SES, race, and gender also affect the preference and choice process. Cosby and Picou (1973) cited numerous sociological studies which support the proposition that SES and geographical location are positively related to adolescent occupational orientations. High SES youth have higher status and occupational attainment orientations than low SES youth. They also reported effects of race. White students had slightly higher

aspirations than black students in the southern United States. When controls were applied, however, the relationship disappeared. The general conclusion was that there are aspects of being either lower class, black, or rural (or a member of any group with differential oppportunity characteristics) which engenders a tendency for lower status occupational orientations.

Pryor (1983) supported earlier research that found females had a stronger person-orientation than males. Males tended to see helping others in the context of organizing and controlling others rather than in personal growth terms. Richardson (1975) did not find any relationship between self concept and career orientation for women. In fact, Osipow (1976) questioned the degree to which self concept implementation through work occurs for women. Barnett (1975) found correlations between preference and prestige were higher for males than females across an age range from nine to seventeen. The correlation for prestige and aversion was higher for females. Barnett feels that women learn to not aspire to high prestige vocations. All of these and similar investigations may prove useful if applied to the problem of engineering as a professional choice for undergraduates.

Implications

A serious fault of most approaches to matching students to engineering careers is their focus on success in college courses.

Baylin and Lynch (1973) pointed out several inconsistencies in post-college engineering careers. Some people identified as working in engineering jobs did not include the word "engineer" in their professional description. Other individuals no longer doing engineering work still included the term in their description. The fact is that there is a wide variety of activities subsumed under the general heading of "engineering". Baylin and Lynch suggest that there is a lack of realism in the presentation that engineering schools make of "on the job" engineering. They reported that engineers who evolve into management positions may feel as if they have prostituted themselves. Additional confirmation of a discrepancy between what engineering is like in college and what engineering is like later in the professional career comes from Schott (1973). In a survey of federally employed engineers, Schott found reports of large discrepancies in several areas between training and application. Federal engineers strongly recommended courses in public administration, business administration, law, sociology, and psychology be included in engineering curricula.

The implementation of an assessment program to determine the degree of suitability students at Texas Tech University have for a career in engineering should assess the entire career. Validation of the specific relationships between objective factors such as high school grades and scholastic aptitude tests should be conducted. These results could indicate which students are likely to prove

incongruent for reason of low aptitude.

The introduction of a seminar for all entering engineering students to provide a realistic preview of the career paths of engineers could help reduce the irritation and uncertainty that engineers may feel as their career develops. A major goal of the assessment paradigm would be to identify those prospective engineers who are somehow different from the prototypical engineer. These are the students most likely to benefit from counseling. Students with characteristics such as low SES, minority standing, and other extrinsic factors, associated with lower vocational maturity may need counseling attention. Low scores in engineering interests, poor grades, and general lack of interest may be indicators an individual should reassess his or her career plans.

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Psychological Models of Engineering Careers: An Analysis of the Strong-Campbell Interest Inventory

Overview

Research has indicated that interest patterns are set by the time a person is 15 years old. The Strong-Campbell Interest Inventory (SCII) has been found valid in studies in which tested groups were compared with E. K. Strong's original sample. Even over as many as 30 years, the interests of a given occupational group remain constant and thus may serve as criteria for recent research. The long-term reliability of the Strong items gives contemporary users of the SCII confidence in their ability to provide accurate and useful counseling to students who are selecting a field in which to major.

The SCII

A major question that has plagued researchers and counselors is how to assist students in selecting occupations which they will enjoy, possibly for a life-time. This is a major undertaking, and a very serious matter. Before a person invests years, energy, and money into an education, it would be worthwhile to apply a reliable and sound procedure to help the student choose an area of study in which he or she will likely succeed and also find interesting. This section focuses on the second part of this procedure, that is, how to help the student find the area which most interests him or her.

As simple as this sounds, this too is a complex issue. What is

an interest? Interest was operationally defined by Strong (1954, p. 7) as: "A response of liking...when we are aware of our set or disposition towards an object." This is a useful guideline, but how does one measure interest? Strong (1954, p. 13) also addressed this problem: "The best way to measure something as subjective as interest is to have the person report their likes and dislikes... there is of course, no way to check the responses...there is no known way to directly determine a person's interests or abilities. Both of these are inferred from what one says and does from the use of tests." With this in mind, Strong (1934) developed an inventory to measure a person's interests. Over the years the Strong Vocational Interest Blank (SVIB) has been modified, renormed, and rewritten. IN 1974, it was modified by David P. Campbell, and the inventory became known as the Strong-Campbell Interest Inventory (SCII). Further modifications by Campbell and Jo-Ida C. Hansen were published in 1981, and a third revision of the SCII is projected for 1985.

Although relatively new, the Strong-Campbell has been used a great deal by researchers and counselors. It has proven to be particularly beneficial to counselors, students, parents, and educators since it provides information helpful in the following ways:

a) The SCII can make occupational and educational choices less ambiguous since the responses are compared to those of a norm group, and thus provide useful information as to how similar a person's interests are to those of people who work

in a given occupation.

b) It can help organize a person's interest preferences into a single readable form and an easily understood model.

c) It can help broaden or narrow a person's field of choices based on his or her interests.

d) It can provide some reassurance to the student (and the student's family) that the individual has chosen an area that can provide the opportunity to satisfy his or her interests.

e) It can also help a person who is dissatisfied or functioning poorly in the work place by pinpointing interests which are not fulfilled by the current job, by suggesting possibilities for change.

In short, the SCII allows people to learn about themselves and their relationship to the working world. This can lead to greater self-understanding which can enable students to make sound educational decisions.

The Strong-Campbell makes use of the Holland scales to impose a theoretical structure that can be interpreted simply and usefully. A basic familiarity with the six Holland types is necessary to understand the results of the SCII. We presented this topic in greater detail with special attention to civil engineers elsewhere, but here is a brief description of the six types as presented in the SCII manual (p. 29-30):

a) Realistic: This person is rugged, practical, and aggressive in outlook.

b) Investigative: This person is scientifically oriented and enjoys abstract problems.

c) Artistic: This person likes self expression; he or she is sensitive and impulsive.

d) Social: This person is person-oriented and humanistic in nature.

e) Enterprising: This person is energetic, enthusiastic, and adventurous.

f) Conventional: This person is well controlled and dependable; he or she prefers ordered activities and stable environments.

How a person scores on each of these scales gives insight about the individual. Individual scores are compared with a normed population; the pattern which emerges identifies the occupational areas which are of greatest interest to the individual as compared to the interests of people already in those occupational areas. Clearly, the utility of this sytem can be recognized in terms of efficiency and its ability to provide useful information to aid in decision making.

Strong (1954, p. 51-52) pointed out that when one is using the interest inventory to counsel a student, one must consider three underlying asumptions to predict outcomes:

a) Permanence of interests: There is substantial evidence to

believe that this is the case. For example the correlation between the test scores of seniors in college and a ten year follow up study was r=.75.

b) Influence of training and experience: There is apparently little that these add to or subtract from a person's interests. If given the opportunity, people tend to pick occupations that satisfy their interests.

c) Validity of prediction: A person will enjoy an occupation if his or her interests are very similar to those of people who are in that occupation and who enjoy it.

One must remember that an interest inventory cannot predict ability or expertise, but only interests. Given equal ability, greater interest in one area may predict higher success than in the other area because the individual would likely be more motivated to persist in an occupation of interest to him or her. Strong further emphasized that as of 1954, researchers had failed in their attempts to differentiate students majoring in one subject area from students in other areas, i.e., college student's academic interests were not differentiable. However, correlations were found between students of one area and persons working in that area. So, even though differentiation between student groups was not achieved, the occupational interests were still intact. Thus, differentiation of student groups must be accomplished using occupational rather than academic interests.

Initially, the age of the student was of concern in that the minimum reasonable age from which good prediction could be made was felt to be too high to be of practical educational value. Strong made the following assumptions about age and the stability of one's interests:

a) 25-55 years, interests are stable.

b) 20-25 years, very slight change

c) 15-20 years, considerable change

After conducting and reviewing research in this area, Strong revised his position. The evidence was overwhelming that interests are stable from the time a person is 15 years old. When a correlation between age groups was performed, the findings were:

a) 25 vs 55, r=.88

b) 15 vs 55, r=.73

With such high correlations consistently found, Strong's data would permit one to safely assume that tested interests of a 15-year-old may be reliably used in prediction. This finding is sufficiently counter to the clinical lore concerning adolescents, however, that despite the lack of variance in interests across the age groups, this matter has been addressed many times. Strong, for example, noted that within the stable interests, differences in maturity levels were reflected in the scores. Concern over age was addressed by Hansen (1978). Hansen found that, in general, an occupational group's perception of the working world was consistent regardless of age.

This held for persons from their 20s through their 50s.

In recent years, the possibility of racial bias in interest testing has become of some concern. Hansen (1978) found that occupational interests differ minimally between black and white respondents, thereby quelling such concerns about the SCII. An age-related question concerns the differences between freshman respondents and senior respondents. This issue was researched by Spokane (1979). When a college freshman class (N=1007) reached their senior year, 600 of them were located and retested. The predictive validity of the Holland scales was found to be as follows:

a) For 232 females, 34.4% hit rate, 34.4% predictive validity;

b) For 386 males, 39.7% hit rate, 43.6% predictive validity.

These results are impressive, particularly when one considers that a correlation of r=.4 is considered very high on paper and pencil tests. One must also keep in mind that this is a college population and not an occupational population.

There has been one major problem area which has haunted the Strong inventories more than other problems and that is that males and females respond differently to most items of interest (Strong, 1973). This problem proved to be the major impetus to the major revision which transformed the SVIB into the SCII in 1974. Since this revision, there have been fewer gender-related problems associated with the Strong, but the issue is not dead. Specific gender-related issues in predicting and counseling among engineering

students are addressed elsewhere.

Whenever professionals make use of a test or scale, they must address themselves to the issue of the measure's reliability. No one wants to invest large amounts of time and money in a measure that is later proven to be out-of-date or ineffective. Fortunately, the SCII is both current and effective. Several longitudinal studies have demonstrated that the inventory is still reliable and useful after a period of 30 years and more. Campbell (1966) reviewed a great deal of research and found studies that sampled medical students, life insurance salesmen, and psychologists, each of which showed that the SVIB was able to discriminate between occupations after many years. Matarazzo, Allen, Saslow, & Wiens et al. (1964) found that police applicants from 1947 were very similar to police applicants of 1959-62. Campbell (1966) reported on a study by Berdie and Hagenah (1948) in which 70 lawyers were tested and compared to Strong's original sample of 20 years earlier; they were found to be very similar. Furthermore, similar findings were obtained for ministers and corporate presidents. Campbell collected additional data that gave strength to the argument that the interest inventory was valid after 30 years, that is, that the person's interests are stable over time and that the characteristics of the criterion group remain constant. Campbell's study involved using some of Strong's original research subjects and conducting a 30 year follow-up. In 1934, 250 bankers were tested by Strong; in 1964, 48 of these original subjects

were retested by Campbell. Persons who held similar positions to these 48 survivors were tested as well. Campbell found that the interest levels of the bankers of 1934 and their retest scores had a correlation of .56. When the 1964 bankers were compared with their 1934 counterparts, the pattern of answers was almost identical, with less than one standard deviation between the scales. This finding is very important since the SCII is based upon the SVIB developed by Strong. Any data that lend support to the reliability of the SVIB automatically give the same support to the SCII.

When everything is considered, the Strong-Campbell Interest Inventory is a remarkable achievement. Very few measures have stood the test of time as well as it has, and fewer have maintained their predictive usefulness across almost 50 years. Due to the overwhelming evidence that the SCII has remained a reliable predictor and measure of individual interests, researchers and counselors can have a high degree of confidence in the information that the SCII provides, thereby allowing students the opportunity to receive sound counseling advice to help them decide in which occupational area they will be most able to satisfy their interests.

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